Wenatchee River Spring Chinook Salmon Population

The Wenatchee Spring Chinook population is part of the Upper Columbia ESU that only has one extant *MPG* including 3 current populations—Wenatchee, Entiat, and Methow Rivers, and one extinct population, the Okanogan (ICTRT 2004). For general descriptions of the subbasins and life history characteristics of these populations see NPPC (2004) or the Upper Columbia Recovery Plan (UCSRB 2006).

The ICTRT classified the Wenatchee River Spring Chinook population as "very large" in size based on historical habitat potential (ICTRT 2005). This classification requires a minimum abundance threshold of 2000 wild spawners with sufficient intrinsic productivity (greater than 1.75 r/s) to exceed a 5 % extinction risk on the viability curve (ICTRT 2005). Additionally, the Wenatchee Spring Chinook population was classified as a "type B" population (based on historic intrinsic potential) because it has dendritic tributary structure with multiple major spawning areas (ICTRT 2005).

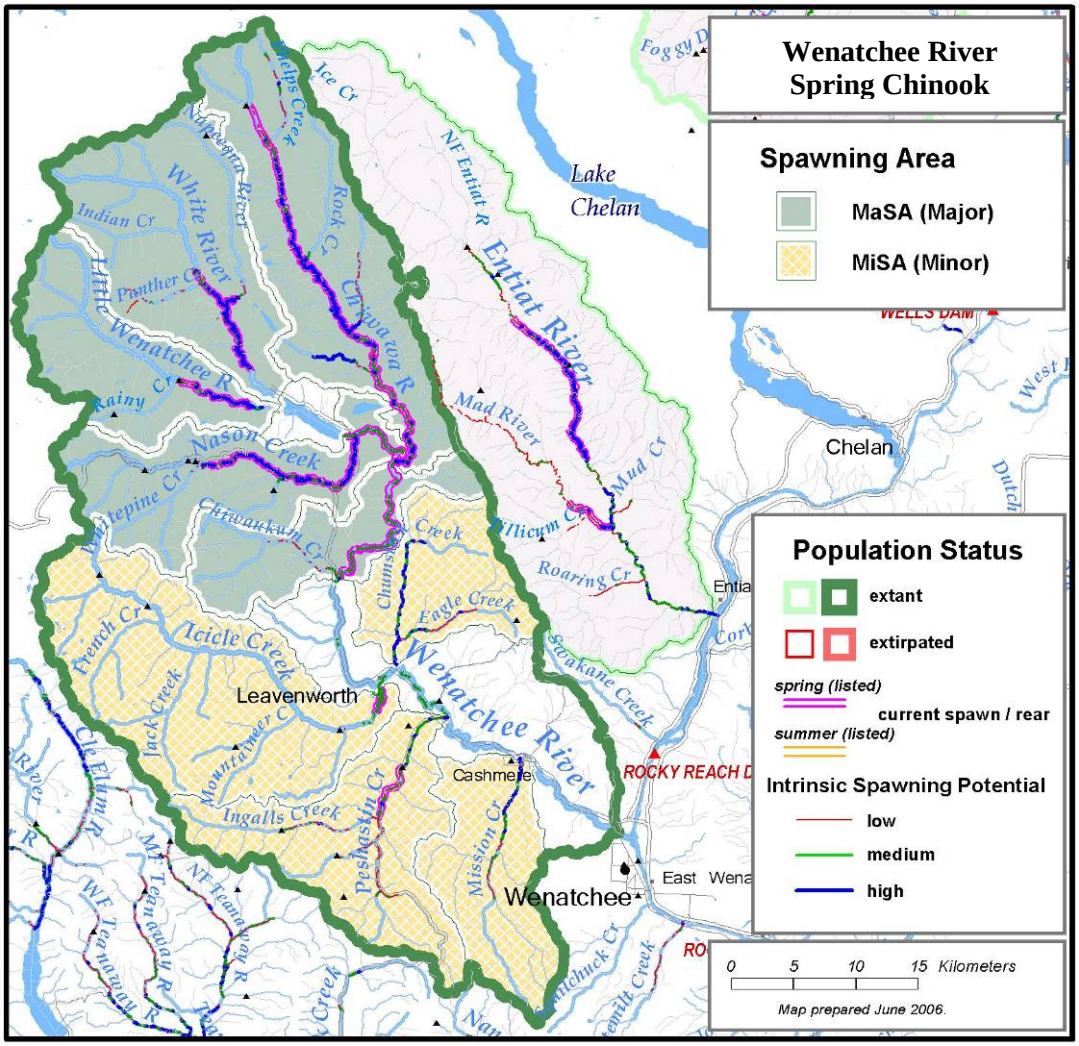

Figure 1. Wenatchee River Spring Chinook Salmon population boundary and major (MaSA) and minor (MiSA) spawning areas.

Table 1. Wenatchee River Spring Chinook Salmon population basin statistics and intrinsic potential analysis summary.

Drainage Area (km2)	3,440
Stream lengths km[a] (total)	1,733.2
Stream lengths km[a] (below natural barriers)	1,082.1
Branched stream area weighted by intrinsic potential (km2)	1.360
Branched stream area km2 (weighted and temp. limited)[b]	1.336
Total stream area weighted by intrinsic potential (km2)	1.883
Total stream area weighted by intrinsic potential (km2) temp limited[b]	1.798
Size / Complexity category	Very Large / B (dendritic structure)
Number of Major Spawning Area	5
Number of Minor Spawning Area	4

[a]All stream segments greater than or equal to 3.8m bankfull width were included

[b]Temperature limited areas were assessed by subtracting area where the mean weekly modeled water temperature was greater than 22°C.

Current Abundance and Productivity

Recent (1960 to 2003) abundance (number of adult spawning in natural production areas) has ranged from 6,718 (1966) to 51 (1995). Abundance estimates are based on expanded redd counts (relatively complete coverage, temporal and spatial components).

Recent year natural spawners include returns originating from naturally spawning parents, strays from the Leavenworth Hatchery program in Icicle Creek and returns from a directed supplementation program (primarily from Chiwawa River releases). Spawners originating from naturally spawning parents have comprised an average of 61%. The most recent 10 year average contribution of naturally produced returns on the spawning grounds has been 62% (Table 2), ranging from 35% to 92%.

Abundance in recent years has been highly variable; the most recent 12-year geomean number of natural spawners was 226 (445 total spawners). During the period 1960-1999, returns per spawner for spring chinook in the Wenatchee subbasin ranged from 0.06 to 4.59. The most recent 20-year (1979-1998) geometric mean of returns per spawner, adjusted for marine survival and delimited at 75% of the size threshold for this population was 0.74 (Table 2).

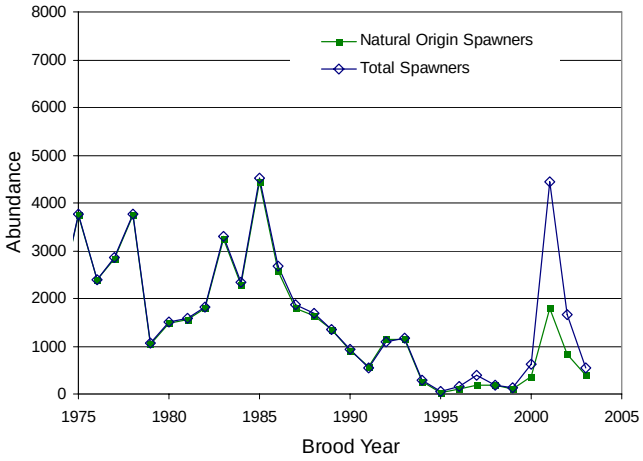

Figure 2. Wenatchee River Spring Chinook Salmon population spawner abundance estimates (1960 to 2003).

Table 2. Wenatchee River Spring Chinook Salmon population abundance and productivity estimates.

10-year geomean natural abundance	226
20-year return/spawner productivity	0.73
20-year return/spawner productivity, SAR adj. and delimited[a]	0.74
20-year Bev-Holt fit productivity, SAR adjusted	1.14
Lambda productivity estimate	1.01
Average proportion natural origin spawners (recent 10 years)	62%
Reproductive success adj. for hatchery origin spawners	No data available

[a]Delimited productivity excludes any spawner/return pair where the spawner number exceeds 75% of the size threshold for this population. This approach attempts to remove density dependence effects that may influence the productivity estimate.

Comparison to Viability Curve

- Abundance: 10-year geomean Natural Origin Returns
- Productivity: 20-year geomean R/S, SAR adjusted and delimited at 75% of the threshold
- Curve: Hockey-Stick curve
- Conclusion: Wenatchee Spring Chinook population is at **HIGH RISK** based on current abundance and productivity. The point estimate for abundance and productivity is below the 25% risk curve.

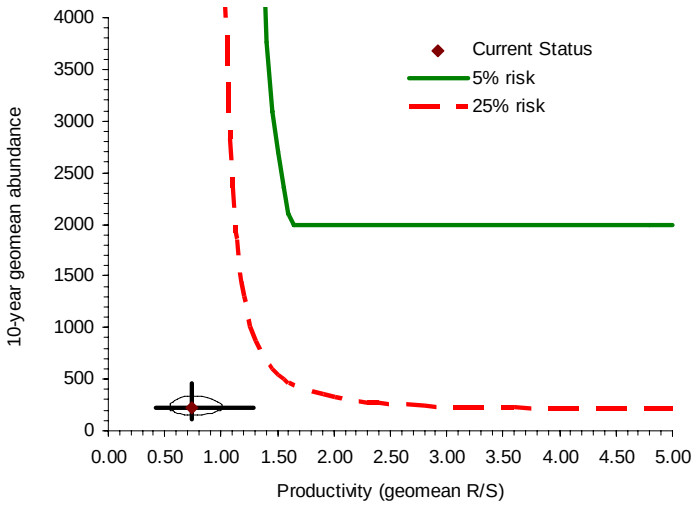

Figure 3. Wenatchee River Spring Chinook Salmon population abundance and productivity compared to the viability curve for this ESU. The point estimate includes a 1 SE ellipse and 95% CI (1.81 X SE abundance line, and 1.80 X SE productivity line).

Spatial Structure and Diversity

The ICTRT has identified five historical major spawning areas (MaSAs) and four minor spawning areas (MiSAs) within the Wenatchee population (Figure 4). The five MaSAs are: Chiwawa, Nason Cr., Little Wenatchee R., White River and the upper Wenatchee mainstem (Tumwater Canyon to Lake Wenatchee). The minor spawning areas (MiSAs) estimated from the intrinsic potential analysis include Icicle, Chumstick, Peshastin, and Mission Creeks.

Currently, the primary spawning areas used by spring Chinook in the Wenatchee are the Chiwawa River, Nason Creek, White River, the Little Wenatchee River and the mainstem Wenatchee between Tumwater Canyon and Lake Wenatchee (Salmonscape 2003; Tonseth 2003). Icicle Creek consistently has unlisted Carson stock spring Chinook spawning below the Leavenworth National Fish Hatchery and, beginning in 2001, Carson stock hatchery spring Chinook have been planted in Peshastin Creek. Redds in these drainages would not contribute to VSP parameters because almost no wild Wenatchee origin fish are known to spawn in these MiSAs. During high abundance years, such as 2001, spring Chinook were also observed in Chiwaukum Creek (A. Murdoch, personal communication).

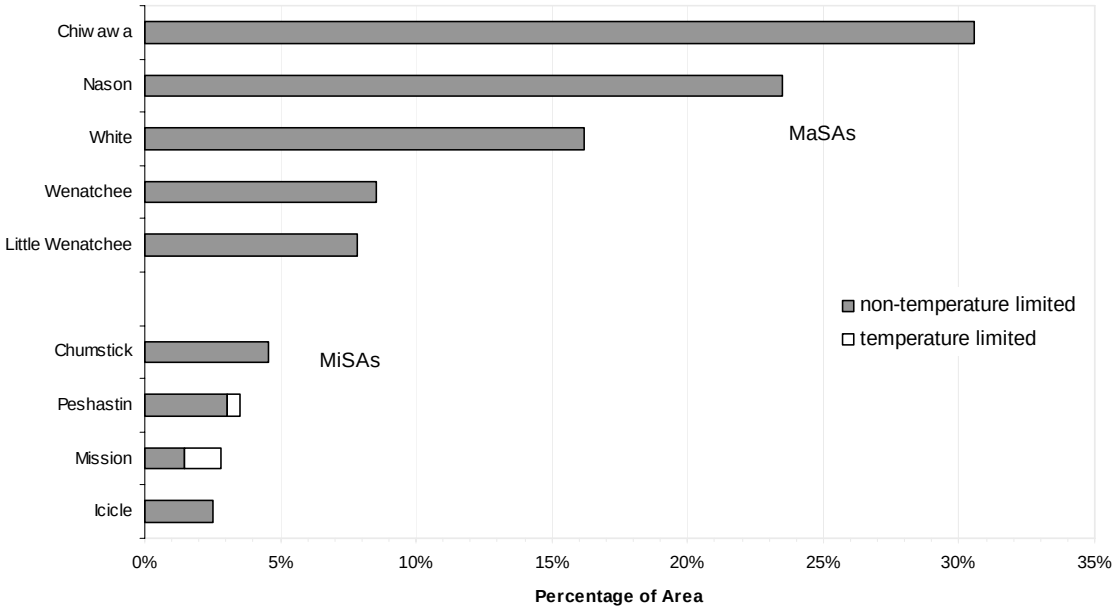

Figure 4. Wenatchee River Spring Chinook Salmon population distribution of intrinsic potential habitat across major and minor spawning areas. White bars represent current temperature limited areas that could potentially have had historical temperature limitations.

Factors and Metrics

A.1.a Number and spatial arrangement of spawning areas. The Wenatchee spring Chinook population has five MaSAs (Chiwawa, Nason, White, and Little Wenatchee, and Upper Wenatchee mainstem) and they are all currently occupied (based on agency defined distribution) so it is at *very low risk*.

A.l.b. Spatial extent or range of population.
The Wenatchee spring Chinook population has five MaSAs (Chiwawa, Nason, White, and Little Wenatchee, and Upper Wenatchee mainstem) and they are all occupied (based on agency defined distribution) so it is at *very low risk*. Additionally, based on redd counts in index areas from the most recent brood cycle (2000-2004) and during the last 3 brood cycles, the Wenatchee population would also be at very low risk. However, there were some years during the last 3 brood cycles that did not meet minimum occupancy requirements in the White, Little Wenatchee, and Upper Wenatchee mainstem MaSAs.

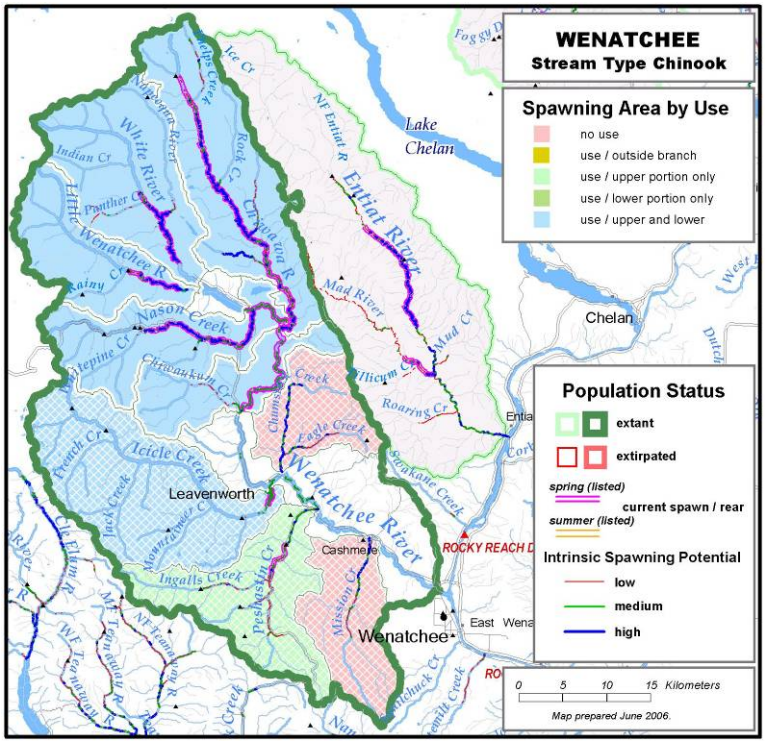

Figure 5. Wenatchee River Spring Chinook Salmon population current spawning distribution and spawning area occupancy designations.

A.1.c. Increase or decrease in gaps or continuities between spawning areas. There has been no increase or decrease in gaps between MaSAs for the Wenatchee spring Chinook population, however the loss of multiple MiSAs at the lower end of the population boundary (below Tumwater Canyon) puts the population at *moderate risk* for this metric. It is assumed that habitat conditions, primarily flow and barriers prohibit the use of Mission and Chumstick Creeks as minor spawning areas. There is considerable uncertainty regarding the ability of these watersheds (Mission and Chumstick) to produce spring Chinook, even under pristine historical conditions. Additionally, there is uncertainty regarding passage of spring Chinook at the Boulder field in Icicle Creek. The opinion of local biologists is that the boulder field always was a barrier (even though road debris has made it artificially enhanced) and recent studies using marked hatchery fish from the LNFH (Cappellini 2001), and historical information from the Wenatchi tribe support that assumption.

B.1.a. Major life history strategies. The Wenatchee spring Chinook population is *very low risk*, because no major life history strategies have been lost.

Studies of juvenile rearing and migration have identified three major juvenile life history patterns within the Wenatchee spring chinook population: summer and overwinter rearing within natal spawning areas, fall presmolt migration and overwintering in the mainstem Wenatchee downstream of natal tributaries, and early summer emigration to downstream areas for summer rearing and overwintering. Limited PIT tagging information indicates that emigrating parr and presmolts use the mainstem reaches above Tumwater Dam for subsequent rearing.

B.1.b. Phenotypic variation. We do not have data available for this metric. Even if we determined that there was a change to one or more traits we do not know what the exact baseline is because changes likely occurred before there was biological monitoring. Therefore, we will assume that there has been some change and increase in variance for 2 or more traits placing the population at *moderate risk.*

B.1.c. Genetic variation. The Wenatchee spring Chinook population was determined to be at *high risk* for genetic variation due to a persistent homogenization from previous fish management efforts. Analyses based on allozymes collected in the 1980s suggest that there was some differentiation between subpopulations consistent with the level of differentiation expected in that time frame, particularly in the White and Twisp drainages. However, microsatellite samples collected in the late 1990s and early 2000s do not show this same differentiation, suggesting that recent management practices may have disrupted natural gene flow (IC-TRT pop id draft, in prep). The ICTRT genetic subgroup has reviewed the current status of all populations in the Interior basin. The subgroup concluded that the Wenatchee population has been homogenized with other UC populations due to past practices. Their conclusion was based on high similarity to all UC hatchery samples and AMOVA analysis indicating no apparent structure between populations, or with minor exceptions, within populations. Data examined include both allozyme and microsatellite data collected by WDFW and analyzed in Ford et al. (2000), and by the IC-TRT genetics subgroup. (Analyses to be published, available upon request.) It is possible that the true genetic risk metric for this population is lower. If additional data becomes available indicating differentiation between and within populations (either genetic data indicating levels of divergence consistent with the time since separation; or genetic information showing strong spatial structure), the risk level for this metric could improve to moderate or low risk.

B.2.a. Spawner composition.

(1) *Out-of-ESU spawners*. The Wenatchee spring Chinook population is at *high risk* with respect to this metric due to the presence of non-local (outside the ESU origin) stocks on the spawning grounds, which include both LNFH and other stocks from hatcheries outside the Upper Columbia ESU. Tagging studies indicate that LNFH stray rates are generally low (<1%) (Pastor 2004). However, based on expanded carcass recoveries from spawning ground surveys (2001-2004), LNFH and other out-of-basin spawners have comprised from 3-27% of the spawner composition above Tumwater Canyon (WDFW unpublished data). Its possible that 4 years of data is not sufficient to evaluate this metric and our risk assessment could change with the inclusion of a longer time series of data. It has been suggested that the mark rate and recovery rate for hatchery fish was insufficient to determine spawner composition prior to 2000 (Andrew

Murdoch, personal communication). Therefore, continuing a 100% external mark rate of hatchery fish and recovering high proportions of carcasses should be a priority.

(2) *Out of MPG spawners*. The Upper Columbia ESU only has one extant MPG, so this metric is *not applicable* and no score will be given.

(3) *Out of population spawners*. Out of population (but within MPG) origin spawners comprised 0% and 1.8% of the naturally spawning population in 2001 and 2002, respectively (Tonseth 2003, 2004). Based on this short-term data set, the population was at *low risk* with respect to this metric. However, we recognize that two years is likely not sufficient to assess long-term risk and conclude that more years need to be added to the time series. Additionally, if the rearing and release practices discussed in the next metric are not addressed then all the hatchery fish on the spawning grounds will fall into this category and the population will be at high risk for this metric.

(4) *Within-population spawners*. Since 1993, a total of 56% of the spawners in tributaries above Tumwater Canyon have been of local hatchery origin, specifically the Chiwawa supplementation program (WDFW unpublished data). Regardless of the duration (# of generations), this high proportion of hatchery fish on the spawning grounds places the population at *high risk* for this metric. Additionally, the Chiwawa River integrated hatchery program strays to other non-target MaSAs and commonly makes up greater than 10 % of the spawner composition in Nason Creek and the White and Little Wenatchee Rivers, based on comprehensive data collected in 2001 and 2002 (Tonseth 2003; Tonseth 2004).

B.3.a. Distribution of population across habitat types.

The intrinsic potential distribution for Wenatchee spring Chinook covered four ecoregions; however, over 90% of the high to medium rated habitat was in two ecoregion types, Chiwaukum Hills and Lowlands and Wenatchee Chelan Highlands. The loss of occupancy in all four MiSAs below Tumwater Canyon did not eliminate an ecoregion type or shift the distribution of ecoregion types by more than 1/3. Therefore, the population was at *low risk* for this metric.

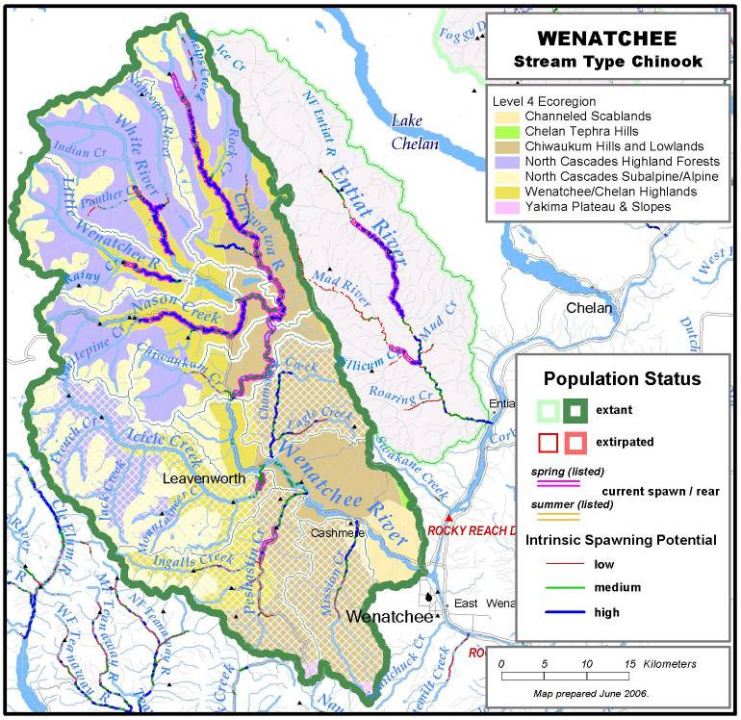

Figure 6. Wenatchee River Spring Chinook Salmon population spawning distribution across EPA level 4 ecoregions.

Table 3. Wenatchee River Spring Chinook Salmon population proportion of current spawning areas across EPA level 4 ecoregions.

Ecoregion	% of historical spawning area in this ecoregion (non-temperature limited)	% of currently occupied spawning area in this ecoregion (non-temperature limited)	% of historical spawning area in this ecoregion (temp. limited)[a]
Channeled Scablands	1.1	0.0	1.1
North Cascades Highland Forests	4.3	3.3	4.3
Wenatchee/Chelan Highlands	41.7	47.6	41.7
Chiwaukum Hills And Lowlands	52.9	49.1	52.9

[a]Temperature limited areas were assessed by subtracting area where the mean weekly modeled water temperature was greater than 22°C.

B.4.a. Selective change in natural processes or selective impacts.

Hydropower system: The hydropower system and associated reservoirs impose some selective mortality on smolt out migrants and upstream migrating adults. The hydrosystem has slowed out migration for early and late out migrants; however, in recent years flow augmentation has reduced the impact to the middle 95% of the run. Additional selective pressures of the hydrosystem that warrant further evaluation to rate this metric include size selective predation by piscivores (Baldwin et al. 2003; Fritz and Pearsons 2006) and size-based differential passage mortality through the hydro projects. The magnitude of selective mortality and the proportion of

the population that is affected are unknown. The selective mortality is not likely to remove more than 25% of the affected individuals, thus we have rated this metric as *low risk*. However, a quantitative assessment using empirical data was not conducted, so there was considerable uncertainty in the conclusion that there are not selective pressures acting on the population that warrant a higher risk rating. When additional information is available this component of selectivity should be re-evaluated.

Harvest: Low risk in recent generations. Harvest rates effect < 20% of the adults and selective gear reduces the impact of selectivity.

Hatcheries: Low risk, broodstock management of the Chiwawa supplementation program has been designed to be non-selective.

Habitat: Low risk, although low flow in Peshastin Creek from water withdrawals could prohibit run timing for late arriving adults, it's a minor proportion of the population.

Based on a low risk rating within all four sectors, the population is at *low risk* for this metric.

Spatial Structure and Diversity Summary

The Wenatchee spring Chinook population was determined to be at low risk for goal A (allowing natural rates and levels of spatially mediated processes) but at high risk for goal B (Maintaining natural levels of variation) resulting in an overall HIGH risk rating. The metrics for genotypic and phenotypic variation were the determining factors for the high risk rating of Wenatchee spring Chinook. We concluded that there was evidence for a high degree of homogenization within the Wenatchee population as well as among the three extant Upper Columbia Spring chinook populations. However, there was considerable uncertainty regarding whether or not the level of divergence in the Wenatchee was sufficient for a moderate risk rating. Therefore continued efforts to maintain natural levels of exchange within and among populations and further evaluation could lead to an improved risk rating. For B.1.b. (phenotypic variation), an analysis needs to be conducted that shows that the phenotypic traits of the current population are consistent with the assumed historical condition or with unaltered reference populations in a similar habitat, geologic, and hydrologic setting. Based on the scoring system, this metric must be addressed in order for the status of goal B to improve to low risk.

There were two metrics that were rated at high risk related to spawner composition that did not directly reduce the overall risk conclusion, but should be considered potential threats to both genotypic (B.1.3) and phenotypic variation (B.1.b). First, Chiwawa River hatchery fish (local origin stock; B.2.a.2) comprise a large portion of the fish on the spawning grounds over multiple generations. Additionally, this hatchery operation is not meeting best management practices because the rearing and release strategies (acclimation of Chiwawa fish on Wenatchee River water over the winter) increase the probability of straying to non-target MaSAs. Second, the high proportion (3-27 %) of LNFH fish (out-of-ESU stock) on the spawning grounds poses an additional risk to genotypic and phenotypic variation. However, due to the scoring system these high-risk ratings were averaged with other metrics and did not directly cause an increased risk rating.

Table 4. Wenatchee River Spring Chinook Salmon population spatial structure and diversity risk rating.

Metric	Risk Assessment Scores				
	Metric	Factor	Mechanism	Goal	Population
A.1.a	VL (2)	VL (2)	Mean = 1.33 Low Risk	Low Risk	**High Risk**
A.1.b	VL (2)	VL (2)			
A.1.c	M (0)	M (0)			
B.1.a	VL (2)	VL (2)	High Risk	High Risk	
B.1.b	M (0)	M (0)			
B.1.c	H (-1)	H (-1)			
B.2.a(1)	H (-1)	High Risk (-1)	High Risk (-1)		
B.2.a(2)	NA				
B.2.a(3)	L (1)				
B.2.a(4)	H (-1)				
B.3.a	L (1)	L (1)	L (1)		
B.4.a	L (1)	L (1)	L (1)		

Overall Risk Rating:

The Wenatchee spring Chinook population is not currently meeting viability criteria. Of particular concern is the high risk rating with respect to abundance and productivity. The population cannot achieve any level of viability without improving its status on the viability curve for both abundance and productivity. Spatial structure and diversity was also rated at high risk, due primarily to a high level of genetic homogenization within and among populations. Improvement of the spatial structure and diversity status to low risk would be required to allow the Wenatchee population to achieve a "highly viable" status (in addition to the improvements needed for abundance and productivity). Based on the MPG guidelines, the Wenatchee population will need to achieve a highly viable status for recovery of the ESU (ICTRT 2005).

		Spatial Structure/Diversity Risk			
		Very Low	**Low**	**Moderate**	**High**
Abundance/ Productivity Risk	**Very Low** (<1%)	HV	HV	V	M
	Low (1-5%)	V	V	V	M
	Moderate (6 – 25%)	M	M	M	
	High (>25%)				Wenatchee

Figure 7. Wenatchee River Spring Chinook Salmon risk ratings integrated across the four viable salmonid population (VSP) metrics. ***Viability Key: HV – Highly Viable; V – Viable; M – Maintained; Shaded cells – does not meet viability criteria (darkest cells are at highest risk).***

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Wenatchee River Spring Chinook Salmon – Data Summary

Data type: Redd count expansions (Wenatchee Spring Chinook without Icicle Creek). Added wild broodstock.

SAR: Expanded Chiwawa SAR index

Table 5. Wenatchee River Spring Chinook Salmon population abundance and productivity data used for curve fits and R/S analysis. Bolded values were used in estimating the current productivity (Table 6).

Brood Year	Spawners	%Wild	Natural Run	Nat. Rtns	R/S	Rel. SAR	Adj. Rtns	adj R/S
1979	**1063**	**0.98**	**1039**	**1406**	**1.32**	**1.32**	**1859**	**1.75**
1980	1519	0.98	1486	3025	1.99	0.80	2408	1.58
1981	1595	0.98	1566	4045	2.54	0.74	2977	1.87
1982	1819	0.98	1786	2873	1.58	0.72	2062	1.13
1983	3286	0.99	3249	1693	0.52	0.80	1358	0.41
1984	2341	0.98	2295	1105	0.47	1.36	1506	0.64
1985	4529	0.98	4445	1380	0.30	1.34	1846	0.41
1986	2674	0.97	2582	886	0.33	1.80	1597	0.60
1987	1878	0.96	1803	1065	0.57	1.48	1575	0.84
1988	1692	0.96	1625	696	0.41	0.73	505	0.30
1989	**1349**	**0.96**	**1347**	**829**	**0.61**	**1.27**	**1054**	**0.78**
1990	**927**	**0.95**	**899**	**183**	**0.20**	**3.12**	**572**	**0.62**
1991	**552**	**1.00**	**582**	**122**	**0.22**	**7.30**	**890**	**1.61**
1992	**1080**	**0.98**	**1140**	**70**	**0.06**	**5.21**	**364**	**0.34**
1993	**1179**	**0.89**	**1146**	**124**	**0.11**	**0.49**	**61**	**0.05**
1994	**275**	**0.89**	**255**	**205**	**0.75**	**1.92**	**394**	**1.43**
1995	**51**	**0.35**	**18**	**229**	**4.53**	**0.41**	**95**	**1.88**
1996	**158**	**0.64**	**109**	**506**	**3.20**	**0.37**	**189**	**1.19**
1997	**385**	**0.40**	**188**	**1768**	**4.59**	**0.15**	**264**	**0.69**
1998	**183**	**0.88**	**174**	**686**	**3.76**	**0.19**	**132**	**0.72**
1999	119	0.92	109					1.75
2000	620	0.55	351					
2001	4446	0.38	1798					
2002	1651	0.51	842					
2003	539	0.71	383					

Table 6. Wenatchee River Spring Chinook Salmon population geometric mean abundance and productivity estimates (values used for current productivity and abundance are shown in boxes).

	R/S measures				Lambda measures		Abundance
	Not adjusted		SAR adjusted		Not adjusted		
delimited	median	75% threshold	median	75% threshold	1987-1998	1979-1998	Nat. origin geomean
Point Est.	0.77	0.75	0.74	0.74	1.02	1.01	226
Std. Err.	0.52	0.47	0.34	0.31	0.65	0.40	0.40
count	10	11	10	11	12	20	10

Table 7. Wenatchee River Spring Chinook Salmon population stock-recruitment curve fit parameter estimates. Biologically unrealistic or highly uncertain values are highlighted in grey.

	Not adjusted for SAR							Adjusted for SAR						
SR Model	a	SE	b	SE	adj. var	auto	AICc	a	SE	b	SE	adj. var	auto	AICc
Rand-Walk	0.73	0.20	n/a	n/a	0.60	0.77	69.6	0.73	0.14	n/a	n/a	0.67	0.16	54.1
Const. Rec	675	173	n/a	n/a	n/a	n/a	66.9	675	171	n/a	n/a	n/a	n/a	66.3
Bev-Holt	3.49	3.58	1001	449	0.38	0.82	67.4	1.14	0.44	2650	1929	0.59	0.23	54.7
Hock-Stk	2.52	1.39	314	193	0.42	0.82	68.9	0.73	0.13	8959	0	0.67	0.16	56.8
Ricker	1.30	0.54	0.00040	0.00023	0.50	0.79	69.5	1.02	0.29	0.00023	0.00016	0.60	0.21	54.9

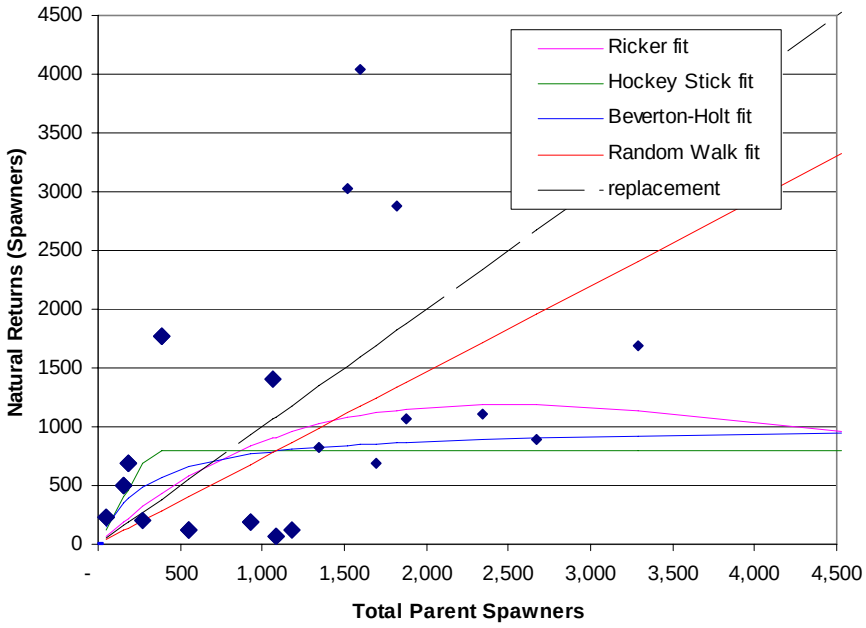

Figure 8. Wenatchee River Spring Chinook Salmon population stock recruitment curves. Bold points were used in estimating the current productivity. Data were not adjusted for marine survival.

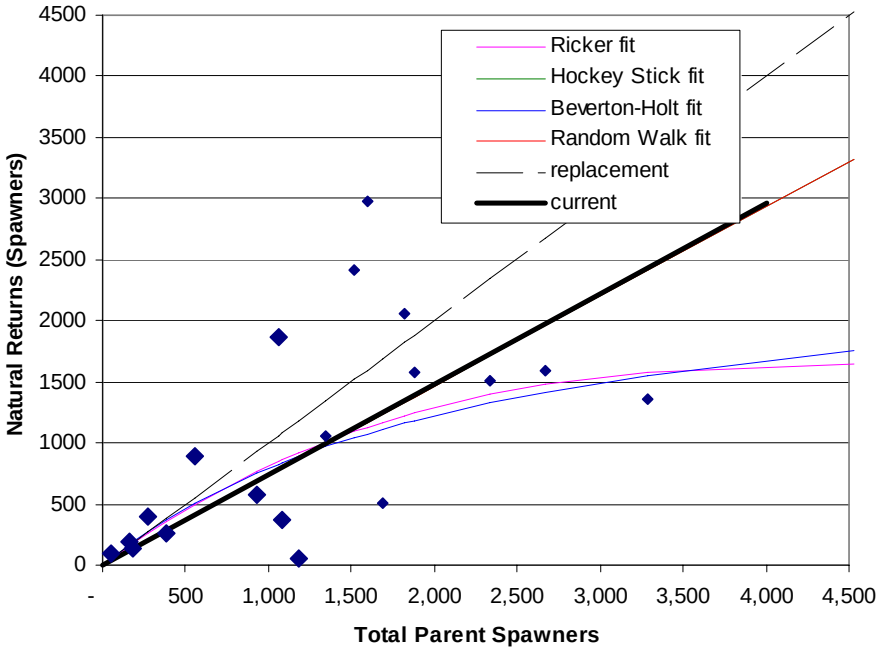

Figure 9. Wenatchee River Spring Chinook Salmon population stock recruitment curves. Bold points were used in estimating the current productivity. Data were adjusted for marine survival.